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B. Ecological Risk Assessment

The major objective of the baseline ecological risk assessment was to evaluate potential adverse effects to ecological resources from exposure to Site contaminants. The baseline ecological risk assessment provides quantitative risk estimates for aquatic communities since information on the nature and extent of contamination suggested that potential impacts to ecological resources were most likely to occur in aquatic areas; thus, data (e.g., quantitative benthic surveys and toxicity testing) were collected to support a full quantitative assessment. The baseline ecological risk assessment provides a qualitative evaluation for terrestrial communities since risks were expected to be small and data collection to support a quantitative assessment was thus not considered necessary. The baseline ecological risk assessment was conducted consistent with applicable United States Environmental Protection Agency guidance documents on ecological assessments and ecological risk assessments.

Contaminant Identification

Risks were evaluated through the development of media-specific ecological effect levels, which are defined as the concentration of a particular contaminant in a particular medium below which no adverse effects to ecological receptors are likely to occur. Ecological effect levels were developed based on established numerical criteria (e.g., United State Environmental Protection Agency and RIDEM ambient water quality criteria) or on information obtained from the literature. These effect levels can be used to assess baseline risks to ecological receptors by comparing the effect levels to existing contaminant levels in the on-site media. In addition, toxicity testing with on-site sediments and leachate served to more fully define baseline risks to aquatic receptors.

Media that were investigated as part of this remedial investigation included surface water, groundwater, leachate, surface sediment, surface soil, subsurface soil, and landfill gas. Based on likely exposure pathways (see section 7.3 of the RI) for species observed or expected to occur on Site, the following exposure pathways were identified for further evaluation under the baseline ecological risk assessment as potential concerns to ecological resources:

- Surface water in the Saugatucket River and Mitchell Brook, as well as in downgradient surface waters fed by these water bodies
- Leachate from landfill seeps
- Surface sediment in the Saugatucket River and Mitchell Brook
- Surface soil, especially in the three disposal areas
- Landfill gas, especially in the Solid Waste Area

Groundwater and subsurface soils (soils at depths greater than two feet) were eliminated as media of ecological concern since organisms on Site have limited direct contact with these media.

Tables 63 through 67 summarize the occurrence of chemicals detected in surface water, leachate, surface sediment, and surface soils samples collected within the Site study area. In summary, chemicals of ecological concern for surface water are aluminum, iron and manganese (Table 68). For leachate, aluminum, iron, lead and manganese are the chemicals of ecological concern while aluminum and iron are of ecological concern in the surface sediments. Copper, lead and manganese were identified as the chemicals of concern for surface soils. No compounds are of ecological concern in landfill gas.

Exposure Assessment

Within exposure assessment, the potential exposure pathways for various species groups such as plants, benthic invertebrates, fish, amphibians, reptiles, mammals and birds were directly or indirectly evaluated to determine those considered to be at risk of significant exposure from Site contaminants.

Table 69 lists the assessment and measurement endpoints for selected species groups for which a potential exposure risk has been identified and for which quantitative data exist. Since only the aquatic system was studied in detail, assessment and measurement endpoints are established only for benthic invertebrates and fish. Terrestrial and semiaquatic taxa were qualitatively evaluated.

Information on the toxicity of the five chemicals of ecological concern (iron, aluminum, manganese, copper, and lead) to ecological receptors was summarized in the toxicity assessment of the ecological risk assessment. In addition, the correlation between the abundance and diversity of species within the benthic community and contaminant concentrations was also presented. Because of the potential synergistic effects of contaminants in sediments and the overall lack of existing sediment toxicity information in the literature, toxicity tests were conducted on sediment samples from three locations at the Site as described in section 2.5.7.6 of the Remedial Investigation. Additionally, toxicity testing was conducted for water column organisms on leachate samples from the Site.

In summary, the results of the correlation analyses indicate that, at least in the water column, total species densities and community structure (occurrence of dominant species) are directly correlated to iron concentration in the Saugatucket River. Total densities and densities of dominant species decrease with increasing iron concentration in the Saugatucket River. This indicates that iron in the water column, although not acutely toxic, is resulting in decreased productivity. The concentration of aluminum does not appear to negatively affect the macrobenthic community.

Toxicity tests were conducted on sediments using two aquatic invertebrates, *Hyalella azteca* and *Ceriodaphnia dubia* and on the fathead minnow, *Pimephales promelas*. Composite leachate samples were collected from the Site and toxicity tests performed using the test organisms, *C. dubia and P. promelas*. The methodologies used in the toxicity testing are described in detail in sections 2.5.7.3 and 2.7.5.4 of the RI. Detailed reports of the tests can be found in Appendix F of the RI.

Table 70 summarizes the mean weight of surviving *Hyalella azteca* in the ten-day growth test. There was variability in growth among samples, but no statistically significant difference in growth was found between samples. The mean weight of surviving organisms in the Saugatucket River was lowest in samples from locations SE-05 and SE-06 (downstream of the leachate seeps), suggesting that the growth of these organisms may be adversely influenced by contamination from the seeps. Sediments from these locations also contained the highest iron concentrations. In Mitchell Brook, the mean weight of surviving organisms was lowest (although not statistically significant) at the two downstream locations (Table 70), suggesting that contamination from the disposal areas may be affecting growth in these organisms.

Percent survival of *Ceriodaphnia dubia* in the Saugatucket River was slightly lower (although not statistically significant) in the samples from locations downstream of the major leachate seep (SE-05, SE-06, SE-11; Table 71), suggesting some potential influence on survival of organisms from the leachate contaminants. In Mitchell Brook, survival was slightly higher in the samples from the two downstream locations (SE-07 and SE-12; Table 71). In general, however, it does not appear that the contamination from the Site significantly affected the survival rate of the test organisms, since mortality at all locations was very low and not statistically difference from the laboratory control samples.

In the Saugatucket River, the survival rate of *Pimephales promelas* was lowest at the most upstream sample location (SE-02) and highest at the most downstream sample location (SE-11). Survival in the intermediate locations varied (Table 72), suggesting that no distinct correlation between survival rate and contamination was associated with the disposal areas adjacent to the river for these organisms. In Mitchell Brook, the survival rate was lower in samples from the two downstream locations (Table 72), suggesting that the survival rate in the brook samples may be influenced by Site contamination. Sediments from these two locations contained higher levels of contaminants than the upstream location. As with the other two test organisms, there was no statistical difference in survival rate between the reference sample and any of the test samples.

Based on the statistical results of these tests, it was concluded that there was no significant difference between the reference and study area samples in sediment toxicity. This indicates that the sediments at the Site do not exhibit acute or chronic toxicity to representative, aquatic species.

Toxicity tests were performed using composite leachate samples from the Site and the test organisms *C. dubia* and *P. promelas*. Results from these tests are summarized in Tables 73 and 74. Test results indicate that the leachate was acutely toxic to *C. dubia* and also caused reproductive effects. Some chronic toxicity also occurred in the fathead minnow (*P. promelas*).

Risk Characterization

As discussed in section 3.4 of the RI, the benthic community in the Saugatucket River is generally diverse. However, community composition and relative abundance of organisms appear to be influenced by the proximity to the landfill and leachate seeps. The benthic grab samples from the sediments adjacent to the largest leachate seep were distinctly different from samples at upstream and downstream locations, indicating that the community structure at this location may be the result of adaption to the chemical influence of the sediments, and thus, is different from the community structure that would be expected in the absence of the chemical influence. Concentrations of the chemicals of ecological concern in the sediments were generally higher at the two locations immediately downstream of the major leachate seep (SE-05 and SE-06) than at the most upstream (SE-02) and most downstream (SE-11) locations. This trend is especially evident for iron, where the concentration at SE-05 and SE-06 is two orders of magnitude greater than at the upstream location. This difference in iron concentration, and to a lesser degree aluminum, may be directly influencing the benthic community structure. Results of the sediment toxicity tests also indicate that contamination in the sediments may result in lower survival rates for sensitive organisms, resulting in a shift in community structure.

In the water column of the Saugatucket River, the density of macroinvertebrates appears to be directly influenced by the disposal areas. The density of organisms significantly decreases downstream of the disposal areas where contaminant concentrations in the surface water are higher. Additionally, the occurrence of pollution-sensitive taxa decreases downstream of the disposal areas, indicating that these species are less able to tolerate the more stressful environmental conditions. This increase in densities of organisms corresponds to an increase in the concentrations of the chemicals of ecological concern in surface water from upstream to downstream locations, especially with respect to iron and manganese.

In Mitchell Brook, as with the Saugatucket River, the benthic community structure associated with contaminated sediments was distinctly different from the structure at locations less influenced by the disposal area contamination. Total species densities were lower downstream of the disposal areas even though the physical characteristics of the sediments were similar. This corresponds to an increase in the concentrations of the chemicals of ecological concern immediately downstream of the disposal areas (SE-09). This indicates that chemical contamination from the disposal areas may be affecting densities. The macrobenthic community in the water column in Mitchell Brook exhibits this same trend of decreased species densities downstream of the disposal areas associated with increased concentrations of the chemicals of ecological concern.

No quantitative assessment of the fish community in the water bodies of the Site study area was conducted. However, based on the physical characteristics of the water bodies (such as water flow and sediment type), these areas would be expected to support both resident and migratory fish populations. However, based on observations made during aquatic sampling, Mitchell Brook and the Saugatucket River do not appear to support a healthy fish community on the Site, since few fish were observed during aquatic sampling. The lack of fish may be related to chemical contamination in the water column since both aluminum and iron exceeded AWQC. AWQC are designed to protect most aquatic organisms from the toxic effects of contaminants. Additionally, results of the leachate toxicity tests indicate that this media can produce chronic toxicity in fathead minnows. Sediment toxicity tests also suggest that there may be decreased survival rates in minnows at sediment contaminant levels associated with the study area.

The *in-situ* benthic community exhibits some apparent effects from Site contamination particularly with respect to community structure (as described in sections 3.4 and 7.5.1 of the RI). However, the results of the correlation analyses suggest that there is no significant linear correlation between species densities and sediment contamination. Also, the results of the sediment toxicity tests indicate that the sediments do not produce acute or chronic toxicity in sensitive aquatic organisms. These results suggest that the effects on the benthic community are likely to be attributable to surface water contamination and not sediment contamination. This is supported by the fact that concentrations of the chemicals of ecological concern in surface water and leachate exceed AWQC and that the leachate is acutely toxic in toxicity tests.

Ecological risk from the chemicals of ecological concern in surface water and leachate can be characterized by comparing contaminant concentrations to known ecological effect levels. For iron and aluminum, the ecological effect levels were based on ambient water quality criteria for protecting aquatic life. For iron, the chronic effect level is 1,000 μg/L in surface water, and for aluminum is 87 μg/L. Iron was measured at up to 65 times the criteria in surface water while aluminum was measured at up to 13 times its criteria value. Concentrations of these chemicals in surface waters throughout the Site frequently exceeded criteria levels, especially in areas downstream of leachate seeps. Thus, there is a risk to aquatic organisms in the surface waters from exposure to these chemicals of ecological concern. Concentrations of iron and aluminum in leachate also exceeded AWQC by up to four orders of magnitude for iron and up to three orders of magnitude for aluminum. The risk to aquatic organisms is confirmed by results from the leachate toxicity testing, which indicated that the leachate is acutely toxic to aquatic organisms. Additionally, the correlation analysis shows significant negative correlation between iron concentration and species densities in the surface water.

In summary, baseline risk to aquatic organisms may occur as a result of exposure to the chemicals of ecological concern in the surface water and leachate. There does not appear to be an existing risk to aquatic organisms due to exposure to sediments.

In contrast, baseline risks to terrestrial and semiaquatic organisms are not likely to be significant over most of the Site study area. Areas of soil associated with leachate seeps, and the leachate itself, may pose some risks to biota. Due to the small areas affected, however, this risk is not likely to be significant. Food chain effects are not of concern, although indirect effects from reduced prey abundance in aquatic areas may be occurring. Small areas of dead trees associated with high methane levels in soil gas are also not considered significant, due to the extremely limited areas over which these effects have been observed.

Uncertainty

There are many sources of uncertainty associated with an ecological risk assessment. Each component of an ecological risk assessment (i.e., receptor selection, toxicity assessment, and exposure assessment) has some uncertainty associated with it. The principal uncertainty associated with this analysis involves the determination of ecological effect levels. For many chemicals, especially for the terrestrial assessment, toxicity data were very limited and criteria values were often unavailable. To compensate for this, the most conservative values were generally used to represent a reasonable worst-case scenario.

A second uncertainty involves using chemical-specific effect levels for individual compounds to assess toxicity. This approach fails to account for multiple exposure pathways, exposures to multiple chemicals, and potential additive or synergistic effects. This uncertainty is most evident for the terrestrial portion of the ecological risk assessment; the aquatic portion included toxicity testing with on-site media, which accounts for these factors.

Conclusion

The baseline human health risk assessment revealed that area adult residents and adult visitors to the Solid Waste Area potentially exposed to compounds of concern in groundwater and air via ingestion and inhalation, respectively, may present an unacceptable human health risk (e.g. cancer risk$>10^{-4}$ or HI>1).

Results of the baseline ecological risk assessment identified concentrations of iron and aluminum in surface waters throughout the Site frequently exceeded criteria levels, especially in areas downstream of leachate seeps. Thus, there is a risk to aquatic organisms in the surface waters from exposure to these chemicals of ecological concern. Concentrations of iron and aluminum in leachate also exceeded AWQC by up to four orders of magnitude for iron and up to three orders of magnitude for aluminum. The risk to aquatic organisms is confirmed by results from the leachate toxicity testing, which indicated that the leachate is acutely toxic to aquatic organisms. Additionally, the correlation analysis between benthic community composition and chemical concentrations, show a significant negative correlation between iron concentration and species densities in the surface water.

The human health and ecological risk assessments identified unacceptable risks posed by actual or threatened releases of hazardous substances from this Site which if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment. Therefore, groundwater, air (i.e., landfill gas) and leachate are the media of focus for the remedial alternatives presented for this Site.

VIII. REMEDIAL OBJECTIVES AND DEVELOPMENT AND SCREENING OF ALTERNATIVES

A. Statutory Requirements/Response Objectives

Under its legal authorities, EPA's primary responsibility at Superfund sites is to undertake remedial actions that are protective of human health and the environment. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences, including: A requirement that EPA's remedial action, when complete, must comply with all federal and more stringent state environmental standards, requirements, criteria or limitations, unless a waiver is invoked; a requirement that EPA select a remedial action that is cost-effective and that utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and a preference for remedies in which treatment which permanently and significantly reduces the volume, toxicity or mobility of the hazardous substances is a principal element over remedies not involving such treatment. Response alternatives were developed to be consistent with these Congressional mandates.

Based on preliminary information relating to types of contaminants, environmental media of concern, and potential exposure pathways, remedial action objectives were developed to aid in the development and screening of alternatives. These remedial action objectives were developed to mitigate existing and future potential threats to public health and the environment. These response objectives are:

- To reduce the potential exposure of area residents and those at the landfill to landfill gases (i.e., vinyl chloride, benzene, 1,1-dichloroethene, and 1,1,2,2-tetrachloroethane) in ambient and indoor air via inhalation that may present a human health risk in excess of the EPA target risk range of 10^{-6} to 10^{-4} for carcinogenic compounds or with a total HI>1 for noncarcinogenic compounds with similar toxic endpoints.

- To reduce the potential exposure of area residents to organic and inorganic contaminants of concern (i.e., vinyl chloride, 1,2-dichloroethene, acrylamide, benzene, pentachlorophenol, bis(2-ethylhexyl)phthalate, antimony, arsenic, cadmium, manganese, beryllium, chromium, and lead) in groundwater via ingestion that may present a human health risk in excess of the EPA target risk range of 10^{-6} to 10^{-4} for carcinogenic compounds or with a total HI>1 for noncarcinogenic compounds with similar toxic endpoints through institutional controls.

- To reduce contaminant migration via leachate to surface waters and sediments of Mitchell Brook in order to improve water quality and designated uses, including aquatic life support.

- To reduce contaminant migration via leachate to surface waters and sediments of the Saugatucket River in order to improve water quality and designated uses, including aquatic life support.

B. Technology and Alternative Development and Screening

CERCLA and the NCP set forth the process by which remedial actions are evaluated and selected. Because many CERCLA municipal landfill sites share similar characteristics, they lend themselves to remediation by similar technologies. EPA has established a number of expectations as to the types of technologies that should be considered and alternatives that should be developed; they are listed in the National Contingency Plan (NCP), 40 CFR 300.430(a)(1). For CERCLA municipal landfill sites, it is expected that;

1. The principal threats posed by a site will be treated wherever practical, such as in the case of remediation of a hot spot.

2. Engineering controls such as containment will be used for waste that poses a relatively low long-term threat or where treatment is impractical.

3. A combination of methods will be used as appropriate to achieve protection of human health and the environment. An example of combined methods for municipal landfill sites would be treatment of hot spot in conjunction with containment (capping) of the landfill contents.

4. Institutional controls such as deed restrictions will be used to supplement engineering controls, as appropriate, to prevent exposure to hazardous wastes.

5. Innovative technologies will be considered when such technologies offer the potential for superior treatment performance or lower costs for performance similar to that of demonstrated technologies.

6. Groundwater will be returned to beneficial uses whenever practical, within a reasonable time, given the particular circumstances of the Site.

In accordance with these requirements, a range of alternatives were developed for the Site.

With respect to source control, the RI/FS developed a range of alternatives in which treatment that reduces the toxicity, mobility, or volume of the hazardous substances is a principal element. This range included an alternative that removes or destroys hazardous substances to the maximum extent feasible, eliminating or minimizing to the degree possible the need for long term management. This range also included alternatives that treat the principal threats posed by the Site but vary in the degree of treatment employed and the quantities and characteristics of the treatment residuals and untreated waste that must be managed; alternative(s) that involve little or no treatment but provide protection through engineering or institutional controls; and a no action alternative.

With respect to ground water response action, the RI/FS developed a limited number of remedial alternatives that attain site specific remediation levels within different timeframes using different technologies; and a no action alternative. However, groundwater will be addressed in a second operable unit, based on monitoring data collected during the implementation of the first operable unit and any additional studies deemed necessary, as explained in Section VII A. above.

As discussed in Section 2 of the FS, treatment technology options were identified, assessed and screened based on implementability, effectiveness, and cost. These technologies were combined into source control (SC) (no action, limited action, containment and treatment,) and management of migration (MOM) alternatives. The MOM alternatives will be evaluated as part of a second operable unit, based on monitoring data collected during the implementation of the first operable unit and any additional studies deemed necessary. Section 3 of the FS presented the remedial alternatives developed by combining the technologies identified in the previous screening process in the categories identified in Section 300.430(e) (3) of the NCP. The purpose of the initial screening was to narrow the number of potential remedial actions for further detailed analysis while preserving a range of options. Each alternative was then evaluated in detail in Sections 4 and 5 of the FS.

In summary, the no action, limited action, and four source control (containment and treatment) remedial alternatives were retained as possible options for the cleanup of the Site. These six alternatives were selected herein for detailed analysis.

IX. DESCRIPTION OF ALTERNATIVES

This Section provides a narrative summary of each alternative evaluated.

- **Alternative 1:** *No-Action*
  The Site would remain as is; there would be no remedial action of any of the contaminated media. However, long-term monitoring of existing ground water monitoring wells, landfill gas and surface water stations located throughout the Site would be monitored for at least thirty years to detect any change that would require intervention. Five-year statutory reviews to determine protectiveness would be conducted as required. A schematic of this alternative is shown in Figure 28, Appendix A.

Estimated Time for Design and Construction:	*<1 year*
Estimated Time of Operation:	*> 30 years*
Estimated Capital Cost:	*$100,000*
*Estimated Operations and Maintenance Costs **(net present worth)**:*	*$3,460,000*
*Estimated Total Cost **(net present worth)**:*	*$3,570,000*

- **Alternative 2:** *Limited Action*
  This alternative would include the long-term environmental monitoring and statutory five-year reviews as described above, establish institutional controls for access and for use of groundwater in the form deed restrictions including land use easements and covenants to prevent access to restricted areas of the Site and to prevent the future use, direct contact and exposure to, or hydraulic alteration of contaminated groundwater. This alternative would also provide landfill gas control contingencies for the nearby residential dwellings which are, or may be, impacted by migrating landfill gas. A schematic of this alternative is shown in Figure 29, Appendix A.

Estimated Time for Design and Construction:	*1 year*
Estimated Time of Operation:	*>30 years*
Estimated Capital Cost:	*$360,000*
*Estimated Operations and Maintenance Costs **(net present worth)**:*	*$3,480,000*
*Estimated Total Cost **(net present worth)**:*	*$3,840,000*

EPA's Preferred Alternative, as presented in the Proposed Plan, was Alternative 3A.

- **Alternative 3A:** *Containment and Landfill Gas Treatment via an Enclosed Flare*
  This alternative would include the long-term environmental monitoring, statutory five-year reviews and establishment of institutional controls as described above, apply protective (Subtitle-C or its performance equivalent), multi-layer caps onto the Solid Waste and Bulky Waste Areas, install an active perimeter and internal gas collection system on the Solid Waste Area with treatment of the gases via combustion through an enclosed flare, and install a passive landfill gas venting system on the Bulky Waste Area. In addition, EPA would collect data to assess the need for conducting any further remedial responses concerning groundwater and surface water as a component of the long-term monitoring program. A schematic of this alternative is shown in Figure 30, Appendix A.

Estimated Time for Design and Construction:	*2 years*
Estimated Time of Operation:	*<15 years for LFG; >30 years GW/Leachate*
Estimated Capital Cost:	*$6,420,000*
*Estimated Operations and Maintenance Costs **(net present worth)**:*	*$7,000,000*
*Estimated Total Cost **(net present worth)**:*	*$13,420,000*

- **Alternative 3B:** *Containment and Landfill Gas Treatment via Photocatalytic Oxidation*
  This alternative would include the long-term environmental monitoring, statutory five-year reviews, establishment of institutional controls, protective covers, installation of a passive landfill gas venting system on the Bulky Waste Area, an active perimeter and internal gas collection system on the Solid Waste Area as described above, with treatment of the gases via photocatalytic oxidation. In addition, EPA would collect data to assess the need for conducting any additional remedial responses concerning groundwater and surface water as a component of the long-term monitoring program. A schematic of this alternative is shown in Figure 31, Appendix A.

Estimated Time for Design and Construction:	*2 years*
Estimated Time of Operation:	*<15 years for LFG; >30 years GW/Leachate*
Estimated Capital Cost:	*$6,560,000*
*Estimated Operations and Maintenance Costs **(net present worth)**:*	*$6,630,000*
*Estimated Total Cost **(net present worth)**:*	*$13,190,000*

- **Alternative 4A:** *Containment, Leachate Collection and On-site Treatment, and Landfill Gas Treatment*
  This alternative would include the long-term environmental monitoring, statutory five-year reviews, establishment of institutional controls, protective covers, installation of a passive landfill gas venting system on the Bulky Waste Area, an active perimeter and internal gas collection system on the Solid Waste Area as described in 3A above. Additionally, added measures to collect and treat leachate in the Bulky Waste Area would be implemented and treated waters would be discharged on-site through injection wells. A schematic of this alternative is shown in Figure 32, Appendix A.

Estimated Time for Design and Construction:	*2 years*
Estimated Time of Operation:	*<15 years for LFG; >30 years GW/Leachate*
Estimated Capital Cost:	*$7,240,000*
*Estimated Operations and Maintenance Costs **(net present worth)**:*	*$8,830,000*
*Estimated Total Cost **(net present worth)**:*	*$16,070,000*

EPA's Selected Remedy is Alternative 4B. The NCP allows EPA to re-evaluate its remedy preference in response to new information and in consideration of comments received during the public comment period. In review of all information and comments received, EPA modified its preferred remedy to Alternative 4B.

- **Alternative 4B:** *<u>Consolidation of the Bulky Waste Area onto the Solid Waste Area, Containment, Leachate Collection and Management (during consolidation), and Landfill Gas Collection and Treatment (Solid Waste Area)</u>*
  This alternative would include the long-term environmental monitoring, statutory five-year reviews and establishment of institutional controls as described above. Instead of capping the Bulky Waste Area, this disposal area would be excavated and consolidated onto the Solid Waste Area which would then be capped and an active perimeter and internal landfill gas collection system installed and treatment of the gases via combustion (enclosed flare) as required to achieve ARARs. Leachate and waters collected from runoff and de-watering operations during the consolidation phase would be managed and discharged according to appropriate regulations. As with Alternative 3A, EPA would collect data to assess the need for conducting any additional remedial responses concerning groundwater and surface water as a component of the long-term monitoring program. A schematic of this alternative is shown in Figure 33, Appendix A.

Estimated Time for Design and Construction:	*2 years*
Estimated Time of Operation:	*<15 years for LFG; >30 years GW/Leachate*
Estimated Capital Cost:	*$11,360,000*
Estimated Operations and Maintenance Costs ***(net present worth)****:*	*$6,680,000*
Estimated Total Cost ***(net present worth)****:*	*$18,040,000*

X. SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

Section 121(b)(1) of CERCLA presents several factors that at a minimum EPA is required to consider in its assessment of alternatives. Building upon these specific statutory mandates, the National Contingency Plan articulates nine evaluation criteria to be used in assessing the individual remedial alternatives.

A detailed analysis was performed on the alternatives using the nine evaluation criteria in order to select a Site remedy. The following is a summary of the comparison of each alternative's strength and weakness with respect to the nine evaluation criteria. These criteria are summarized as follows:

Threshold Criteria

The two threshold criteria described below must be met in order for the alternatives to be eligible for selection in accordance with the NCP.

1. **Overall protection of human health and the environment** addresses whether or not a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced or controlled through treatment, engineering

controls, or institutional controls.

2. **Compliance with applicable or relevant and appropriate requirements (ARARs)** addresses whether or not a remedy will meet all of the ARARs of other Federal and State environmental laws and/or provide grounds for invoking a waiver.

Primary Balancing Criteria

The following five criteria are utilized to compare and evaluate the elements of one alternative to another that meet the threshold criteria.

3. **Long-term effectiveness and permanence** addresses the criteria that are utilized to assess alternatives for the long-term effectiveness and permanence they afford, along with the degree of certainty that they will prove successful.

4. **Reduction of toxicity, mobility, or volume through treatment** addresses the degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume, including how treatment is used to address the principal threats posed by the Site.

5. **Short term effectiveness** addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period, until cleanup goals are achieved.

6. **Implementability** addresses the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

7. **Cost** includes estimated capital and Operation and Maintenance (O&M) costs, as well as present-worth costs.

Modifying Criteria

The modifying criteria are used on the final evaluation of remedial alternatives generally after EPA has received public comment on the RI/FS and Proposed Plan.

8. **State acceptance** addresses the State's position and key concerns related to the preferred alternative and other alternatives, and the State's comments on ARARs or the proposed use of waivers.

9. **Community acceptance** addresses the public's general response to the alternatives described in the Proposed Plan and RI/FS report.

A detailed tabular assessment of each alternative according to the nine criteria can be found in Table 5-1 of the Feasibility Study.

Following the detailed analysis of each individual alternative, a comparative analysis, focusing on the relative performance of each alternative against the nine criteria, was conducted. The section below presents the nine criteria and a brief narrative summary of the alternatives and the strengths and weaknesses according to the detailed and comparative analysis.

1. Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

The preamble to the NCP and EPA's Guidance for conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites, OSWER Dir. 9355.3-11 (Febuarary, 1991) identifies municipal landfills as a type of site where treatment of the waste may be impracticable because of the size and heterogeneity of the contents. EPA generally considers containment to be an appropriate response action for large municipal landfills. Because the Rose Hill Regional Landfill Site is a large municipal landfill, the alternatives evaluated consider containment of the wastes to be the appropriate response action for source control. Further, consideration of consolidation of the Bulky Waste materials onto the Solid Waste Area provides for added protectiveness to ecological receptors by removing an uncontrolled source area from the proximity of the Saugatucket River wetland and bank and consolidating these materials into a single waste area to be properly controlled and appropriately monitored. In addition, innovative cap materials will be considered when such materials offer the potential for superior performance or lower costs for performance equivalent to that of demonstrated materials.

Alternatives 1 and 2 do not meet this criterion, while Alternatives 4A and 4B would attain adequate protection of human health and the environment, with 4B offering a higher degree of environmental protectiveness through the excavation and consolidation of the bulky waste area. Alternatives 3A and 3B would attain adequate protection of human health, but would only approach adequate attainment for protection of the environment, since some amount of leachate continue to reach surface water/sediment bodies. Alternatives 3A through 4B capture and treat landfill gas emissions in protection of human health. Under 3A and 3B, additional response actions would likely be necessary for the Bulky Waste Area (BWA) since leachate would continue to be produced after the caps were installed and functioning. This is primarily due to the anticipated seasonal fluctuations of ground water elevations contacting wastes beneath the Bulky

Waste landfill cap. While reduced by the placement of a cap on the BWA, leachate breakout may continue to impact the Saugatucket River.

Human Health Protection

Alternative 1 provides no protection against human health risks and, thus, does not meet this threshold criteria. The estimated cancer risk and hazard index would continue to exceed EPA's target cancer risk range of 10^{-6} to 10^{-4} and the target non-cancer risk limit of 1 for those exposure pathways identified in the baseline risk assessment. Alternative 1 also provides no protection from potential future risks if off-site migration of contamination occurs. This Alternative will not be carried through the rest of the comparative analysis, except for cost.

Alternative 2 uses institutional controls (access and ground water restrictions in the form of easements and covenants) and landfill gas control contingency measures to provide some degree of overall protection of human health by reducing the potential for human exposures to occur. Overall risks to human health at the Site may be lessened by Alternative 2. Considering the magnitude of risk posed at the Site and the geographic extent of the ground water exceedances of water quality standards and extent of landfill gas emissions, institutional controls and the contingency measures, by themselves, are inadequate to provide protectiveness at the Site over the long term. Therefore, Alternative 2, which relies solely on institutional controls and contingency measures where risk is demonstrated to be outside EPA's acceptable risk range, are less protective than alternatives 3A through 4B. Since contamination at the Site is not reduced or contained under this alternative, off-site exposures to COCs in ambient air or indoor air at nearby residences would exceed the EPA target cancer risk range. This occurs even at locations with the residential LFG control contingency since these systems are appropriate only for reducing safety risks from methane in soil gas.

Human health risks from inhalation exposures are reduced to acceptable levels by engineering controls and access restrictions for Alternatives 3A through 4B. These alternatives also use engineering controls to increase the protection of human health from inhalation exposures to COCs originating in landfill gas (cap installation, LFG collection, and treatment of LFG at the Solid Waste Area). Risks from inhalation exposures to COCs in soil gas in ambient air and indoor air at nearby residences are expected to be reduced to within EPA's target risk range under these alternatives.

Alternative 2 does not provide source reduction of existing groundwater contamination at the Site; Alternatives 3A through 4A do provide source reduction through installation of a cap in alternatives as well as provide leachate control to help reduce subsequent groundwater impacts by minimizing infiltration from precipitation. Alternative 4B adds and extra measure of protectiveness by physically moving part of the source waste out of the groundwater table and away from the Saugatucket River through excavation and consolidation of the bulky waste area. Furthermore, Alternatives 4A and 4B use a leachate collection and contaminant management system to provide additional leachate control. For Alternatives 3A through 4B, potential future risks from groundwater ingestion at the Site would not exceed the EPA target cancer risk range as long as groundwater institutional controls are fully implemented and remain effective. Overall protection of human health from this exposure pathway for Alternatives 3A through 4B would also depend on long-term monitoring.

Ecological Protection

The no action and limited action alternatives, Alternative 1 and 2, respectively, are not protective of the environment and, thus, do not satisfy this criterion. These alternatives provide no reduction in long- or short-term risks to ecological receptors relative to baseline levels since there would be no reduction in contaminant migration via leachate and groundwater. Therefore, the documented adverse impacts to the aquatic community as were described in Section VII. B, especially to Mitchell Brook and the Saugatucket River, would persist under these two alternatives.

Under Alternatives 3A and 3B, capping of the two disposal areas would decrease ecological exposures to site-related contaminants in wetland and aquatic habitats since leachate generation and subsequent discharge to Mitchell Brook and the Saugatucket River would be reduced.

Alternatives 4A and 4B are more protective of the environment, since capping of the disposal areas, landfill consolidation and installation of leachate collection and a contaminant management system would prevent additional migration of Site-related contaminants to wetland and aquatic habitats. Leachate generation and subsequent discharge to Mitchell Brook and the Saugatucket River would be substantially controlled under Alternative 4A; and virtually eliminated under Alternative 4B. Alternative 4A would allow for collection and treatment of leachates through the duration of the response whereas Alternative 4B need only provide short-term collection and treatment of leachate during the consolidation process.

The remedial alternatives differ in the magnitude of potential impacts to ecological habitats. While the no action alternative would not disturb ecological habitats, contaminants would remain to continue their adverse effects on the habitats. For the limited action alternative, some minor, short-term impacts to small areas of wetland and upland habitats would occur due to fence installation. For Alternatives 3A, 3B, and 4A, capping the disposal areas and constructing the leachate collection and management system would result in some temporary and/or minor impacts to ecological habitat, the filling of one small emergent wetland forming in a depression within the landfill (<0.15 acres) and impacts to forested wetlands (0 to 0.5 acres). These potential impacts can be mitigated and are lowest for Alternatives 3A and 3B and highest for Alternatives 4A and 4B (due to the number and extent of remedial actions to be conducted).

For Alternatives 3A through 4B, the caps and leachate collection/management systems also have the potential to affect the hydrology of on-site wetlands, Saugatucket River and Mitchell Brook. These potential impacts are relatively low for Alternatives 3A and 3B compared to Alternatives 4A and 4B (due to the presence of leachate collection systems). However, most impacts can be mitigated through engineering controls.

2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

Section 121(d) of CERCLA requires that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs," unless such ARARs are waived under CERCLA section 121(d)(4).

Applicable requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address hazardous substances, the remedial action to be implemented at the Site, the location of the Site, or other circumstances present at the Site. Relevant and appropriate requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law which, while not applicable to the hazardous materials found at the Site, the remedial action itself, the Site location or other circumstances at the Site, nevertheless address problems or situations sufficiently similar to those encountered at the Site that their use is well-suited to the Site.

Compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of other Federal and State environmental statutes or provides a basis for a invoking waiver.

Compliance with ARARs is met by Alternatives 3A through 4B but not attained by Alternatives 1 and 2.

The no action and limited action alternatives, Alternatives 1 and 2 respectively, fail to meet requirements for hazardous waste landfills. Alternatives 3A through 4B meet the Rhode Island and federal regulatory requirements for a hazardous waste landfill cap.

Since this Record of Decision anticipates a source control response, ground water cleanup is not addressed and cleanup goals are not set for any of the alternatives. A second operable unit response is planned to evaluate and manage the migration of contaminants that have impacted, or may continue to impact, local area groundwater. However, all alternatives will comply with those portions of the regulations which apply to installing groundwater monitoring wells and compliance monitoring. Management of the migration of contaminants to ground water will be based on data obtained from the first operable unit monitoring and any additional studies that are deemed necessary in order to further characterize the extent of contamination to ground water.

A similar approach will be taken with respect to surface water. As a source control response, surface water clean up is not addressed in this operable unit. Therefore water quality standards will be used to measure the effectiveness of the remedy with respect to cap effectiveness, leachate production, and any other discharges to on-site surface water. Management of the migration of contaminants to surface water will be based on data obtained from the first operable unit monitoring and any additional studies for assessing any continued impact to surface water.

Landfill gas emissions controls, proposed under Alternatives 3A through 4B, would be designed, installed, and operated to meet Rhode Island Air Pollution Control Regulations and the federal Clean Air Act. Emissions from the gas treatment systems would attain RIDEM Air Pollution Control Regulation No. 7, which prohibits the emission of air contaminants detrimental to person or property. These emissions would also be expected to be below the minimum reportable quantities and acceptable ambient levels set forth in RIDEM air toxics rules, No. 22. Under this regulation, air quality modeling may be required to determine allowable emissions.

Alternatives 3A through 4B also include a condensate aboveground storage tank and condensate pump stations which are regulated as ancillary equipment to tanks. This condensate is assumed to be hazardous by characteristic and would require off-site disposal at a RCRA-compliant TSDF. The tank and pump stations would need to be installed in compliance with state and federal tank rules. Underground components would also need to comply with appropriate UST rules.

For Alternative 2, there would be no actions taken in wetlands or buffer zones. For Alternatives 3A through 4B, wetlands-related ARARs would be met through on-site mitigation (replacement of forested wetlands) and through proper hydrological design (to mitigate potential hydrological impacts to surface water bodies and wetlands due to the caps and/or the collection and treatment systems).

State ARARs relating to threatened and endangered species or their habitat, if any are found, would be met under all alternatives through consultation with the appropriate state agency. The baseline ecological risk assessment did not identify any significant exposure pathways to Site contaminants for any endangered species which could potentially occur on the Site.

For Alternatives 3A through 4B, actions must be taken during construction to protect (or mitigate unavoidable impacts to) wetlands, surface water bodies, the flood plain, and the nearby cemetery.

3. Long-term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once clean-up levels have been met. This criterion includes the consideration of residual risk and the adequacy and reliability of controls.

This section summarizes the evaluation for risks remaining at the Site after Remedial Action Objectives have been met, and risk from management of residuals.

Magnitude of Residual Risk: Human Health

Exposure pathways which exceed acceptable human health risk levels include inhalation exposures at the Site, inhalation exposures from indoor air and ambient air at off-site receptors and groundwater ingestion exposures at the Site.

Alternative 2 does not provide long-term effectiveness and permanence since no source reduction or containment measures are implemented under this alternative. While this alternative reduces residual human health risks through the use of institutional controls and residential landfill gas contingencies, residual human health risks from ambient air inhalation exposures of off-site receptors may continue to exceed acceptable risk levels.

Through engineering controls and treatment, Alternatives 3A through 4B provide an increase in long-term effectiveness and permanence compared to Alternative 2 by controlling and reducing Site COCs in ambient air and soil gas. As a result, residual human health risks from inhalation exposures at off-site receptors would be reduced to acceptable risk levels.

Alternatives 3A through 4B also provide increased long-term effectiveness and permanence with respect to residual human health risks from exposures to groundwater contamination over Alternative 2. Active remediation including capping, landfill gas and leachate collection and management in addition to institutional controls provide greater reductions in long-term residual human health risks from ingestion of groundwater. Alternative 4B provides the greatest long-term effectiveness and permanence with regard to site risks through the physical removal of the bulky waste source area from the groundwater table and from the proximity to the Saugatucket River.

There are some byproducts resulting from the treatment trains proposed for the various alternatives that could pose long-term risks; however, these potential risks are assumed to be minimal since they could be mitigated by using appropriate engineering controls where possible and by using proper operating and transport methods and procedures. For example, the LFG collection and treatment system proposed for Alternatives 3A through 4B will produce a condensate waste stream and combustion products at the enclosed flare. Alternatives 4A and 4B will generate byproducts from the treatment train for collected leachate. However, these waste streams and off-gasses will be properly managed and the risk is thought to be minimal.

Magnitude of Residual Risk: Ecological

The limited action Alternative 2 would not result in a quantifiable long-term reduction in risk to ecological receptors since leachate would continue to be generated and enter Mitchell Brook and the Saugatucket River. Documented adverse impacts to the aquatic communities in these water bodies would continue from exposure to this leachate.

Long-term risks to ecological receptors in wetland and aquatic habitats would be reduced under Alternatives 3A through 4A due to installation of caps on the Solid Waste and Bulky Waste Areas. Long-term risks to ecological receptors in wetland and aquatic habitats would be significantly reduced or eliminated under Alternatives 4B.

Adequacy and Reliability of Controls

Alternative 2 would not involve treatment controls for groundwater/leachate or landfill gas, but provides protection through access and ground water restrictions (easements and covenants) and the LFG control contingency. The effectiveness of these controls is based upon their ability to be readily enforced by both private parties and governmental agencies. Such controls also depend on the cooperation of adjacent property owners. Therefore institutional controls, by themselves, are not sufficient as the sole protective measures implemented at the Site. Further, these controls are dependent upon the frequency of routine monitoring. The adequacy and reliability of monitoring is, in turn, dependent upon the use of proper sampling and analytical procedures. Even if institutional controls are effective, however, protection of human health from risks posed by off-site inhalation of ambient air is not adequate under Alternative 2.

Horizontal containment (capping) proposed under Alternatives 3A through 4B would adequately reduce or eliminate the infiltration of precipitation into waste, thereby reducing the generation of leachate. The cap would require long-term maintenance to ensure that its integrity is not compromised. The cap would also reduce the groundwater mound reducing contact between in-place refuse and groundwater. This action reduces the volume of groundwater that becomes contaminated as well as the quantity of leachate produced. The caps, however, may not eliminate all leachate production. There is a high degree of confidence associated with caps in relation to their ability to reduce infiltration of precipitation and control the escape of landfill gas.

The leachate collection system proposed under Alternatives 4A and 4B would reduce the leachate production near the Saugatucket River. Fencing and/or other security measures will prevent the public from coming in contact with untreated water and management systems.

Excavation and consolidation of the Bulky Waste Area (Alternative 4B) would eliminate the future generation of leachate from the Bulky Waste Area, assuming all contaminants are removed. If removal of waste is incomplete (i.e., some wastes remain in place) in the Bulky Waste Area, additional controls (i.e., a cap and long-term leachate collection) may be necessary. Further, monitoring of the groundwater and surface water after the Bulky Waste material is excavated and consolidated under the cap, will collect data to assess the extent to which the attenuation of these residuals is occurring, so any unacceptable impact to local groundwater and surface waters can be addressed in OU 2 as required.

The reliability and adequacy of the LFG collection and treatment systems proposed under Alternatives 3A through 4B is initially dependent on the collection system. Landfill gas not captured by the active internal collection system would be captured by the active perimeter collection system. The perimeter system and cap provide a secondary containment of landfill gas and further reduce fugitive emissions to ambient air.

Treatment by enclosed flare is proposed for Alternatives 3A, 4A and 4B. The release of untreated Site COCs exiting the enclosed flare would be very low due to the high destruction removal efficiencies that can be expected (95% minimum for all VOCs).

Alternative 3B proposes LFG treatment by photocatalytic oxidation. Because photocatalytic oxidation is an innovative technology, its reliability over years of operation has not been determined. The technology has not yet been tested on landfill gas. Therefore, alternatives 3A, 4A and 4B are considered more reliable than 3B.

Each of the alternatives would require periodic five-year reviews to examine the reliability and adequacy of the options and technologies selected. Five year reviews would be necessary to evaluate the effectiveness of any of these alternatives because hazardous substances would remain on-site in concentrations above health-based levels.

4. **Reduction of Toxicity, Mobility, or Volume through Treatment**

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Treatment/Recycling Processes Utilized

Alternative 2 does not utilize any treatment processes beyond natural attenuation and therefore do not remediate source areas. In Alternative 2, utilization of the LFG control contingency would only result in negligible reduction of toxicity, mobility, and volume of the treated waste. Alternatives 3A, 4A, and 4B treat captured landfill gases by combustion in an enclosed flare, reducing the toxicity and mobility of landfill gas migrating off the Site. Similar to Alternative 3A, Alternative 3B also treats COCs in LFG, but does not destroy methane. Alternatives 4A and 4B additionally treat groundwater/leachate using precipitation, media filtration and UV/chemical oxidation.

Amount of Hazardous Materials Treated or Recycled

The total flow rate of leachate that would be managed under Alternatives 4A and 4B is approximately 5 gpm. Under Alternative 4B, the Bulky Waste Area leachate is expected to comprise all of this flow during excavation and consolidation process. During landfill excavation and consolidation the flow rate of leachate at the Bulky Waste Area may increase or fluctuate due to ground disturbances and/or dewatering processes but will be virtually eliminated once consolidation is complete.

Under Alternatives 3A, 4A, and 4B the majority of the LFG would be burned using an enclosed flare. Under Alternative 3B, the majority of the LFG would be treated using photocatalytic oxidation. Only limited quantities of landfill gas would be addressed under Alternative 2 through the residential LFG control contingency.

Degree of Expected Reductions in Toxicity, Mobility, or Volume

While none of the alternatives remove the source of LFG contamination, Alternatives 3A through 4B provide the greatest degree of reduction in COC toxicity, mobility, and volume from landfill gas through appropriate controls. Alternatives 3A, 3B, and 4A provide progressively more reduction in COC toxicity, mobility and volume for groundwater/leachate. Alternative 4B, when completed, provides the most long-term reduction in leachate COC mobility and volume than Alternatives 3A through 4A since the Bulky Waste Area landfill will be excavated and consolidated away from the Saugatucket River..

Irreversibility

Alternatives 3A through 4B are irreversible with respect to implemented treatment technologies and process options which destroy Site COCs. To a small extent, Alternative 2 (through the LFG control contingency) also irreversibly removes or destroys Site COCs.

Type and Quantity of Residuals

Alternative 3A would generate condensate from the landfill gas collection system as well as combustion by-products. Landfill gas condensate is expected to generate at a rate of 125 gal/10^6 ft^3 of extracted gas. Combustion gases would be expected to include trace nitrogen oxides, sulfur oxides, and small quantities of undestroyed COCs. Alternative 3B would also generate condensate from the LFG collection system as well as residuals such as methane and possibly small quantities of hydrogen chloride. Alternatives 4A and 4B would generate landfill gas condensate and combustion by-products (at the same rates as predicted for Alternative 3A). Drilling and construction soils from installation of the LFG collection and treatment system and filter sludges from the leachate management systems would also be generated. The sludge would be expected to contain hydroxide sludges of aluminum, iron, and manganese. Alternative 4B would generate waste, soil and scrap metal residuals during landfill excavation. There may also be minor amounts of hazardous waste encountered under this alternative. These residuals will be properly handled through appropriate waste management and disposal practices.

Further reduction in toxicity and mobility of Site COCs in groundwater would be achieved with Alternative 4B. Landfill consolidation would eliminate a waste source (Bulky Waste Area) from the immediate vicinity of the Saugatucket River and from within the water table in this area.

5. Short-term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers and the community during construction and operation of the remedy until cleanup goals are achieved.

Protection of Community and Workers During Remedial Actions

Short-term risks include any additional risks to the community or workers at the Site from exposures as a result of construction measures and implementation of remediation activities.

Alternative 2 has nominal increases of short-term risks due to installation of the residential LFG control contingency as well as fence installation.

Alternatives 3A through 4B would result in additional short-term risks to the community and workers from ingestion and inhalation exposures to soil particles in dust during preparation of disposal areas for capping and inhalation exposures to VOCs from invasive work at the Solid Waste Area. Air sampling and monitoring would be used to evaluate any potential risks from inhalation exposures, and engineering controls would be used to reduce any potential inhalation risks from invasive activities. Dust control measures would be used to mitigate potential soil ingestion or inhalation exposures. Concentrations of COCs are expected to be the highest at the Site, therefore, workers at the Site would also use appropriate PPE to mitigate any potential risks from exposures.

Alternatives 4A and 4B may present short-term risks in addition to those described for Alternatives 3A and 3B, as a result of additional invasive work required for the installation of leachate collection and management system. These short-term risks can be mitigated by a variety of measures. Air sampling and monitoring would be used to evaluate any potential risks to the community. As discussed above, engineering controls would also be used to minimize the degree of invasive work to mitigate potential risks from this exposure pathway. Workers would also wear appropriate PPE to mitigate any potential risks from increased exposures at the Site. Alternative 4B also present short-term risks due to landfill excavation and consolidation of the Bulky Waste Area landfill onto the Solid Waste Area landfill. Similar to above, these risks could be mitigated by sampling/monitoring, engineering controls and PPE.

Environmental Impacts

Minimal short-term habitat impacts would occur under Alternative 2. Short-term risks to ecological receptors are likely to increase slightly due to the mobilization of contaminants during horizontal containment operations for Alternatives 3A through 4B. These alternatives would also temporarily displace some resident organisms, and some mortality of resident organisms would occur during capping operations.

Direct, relatively short-term (1 year) habitat impacts would occur during remedial construction activities for Alternatives 3A through 4B and would affect approximately 30 acres of habitat, including one small emergent wetland and up to 0.5 acres of forested wetlands (Alternatives 4A and 4B). Most of the impacted areas occur on top of the disposal areas; the primary disturbance would occur during installation of the caps. These impacts are lowest for Alternative 3A and 3B and highest for Alternatives 4A and 4B (due to the greater extent of remedial activities), although differences among these alternatives are not substantial. Additional disturbances include construction of roadways, leachate collection systems, and installation of materials management facilities. Disturbed areas would be restored following remediation. The increase for potential erosion, run-off, and sedimentation related to invasive activities for Alternatives 4A and 4B would be mitigated with appropriate engineering controls.

Time Until Remedial Action Objectives are Achieved

The time required to meet RAOs varies depending upon the active remedial measures for these disposal areas.

For Alternative 2 the time to achieve the RAO for landfill gas and leachate will exceed 30 years since there is no active treatment; for Alternatives 3A through 4B the timeframe falls to less than 15 years for landfill gas because active treatment is part of the remedy. To achieve the RAO for leachate in Alternative 3A and 3B, the timeframe is greater than 30 years because there is no active leachate control; for Alternatives 4A and 4B the RAO is achieved much sooner given the leachate control and management system. Consolidation of the bulky waste area in Alternative 4B may accelerate the time to reach the RAO for leachate by removing a significant source from the vicinity of the River.

For groundwater, all Alternatives reach the RAO of prohibiting ingestion through institutional controls at the same time.

6. Implementability

Technical Feasibility

There are not significant differences between Alternatives 3A, 3B, and 4A with regard to ability to construct and operate the associated technologies and process options. Alternatives 4B is similar to those above except for consolidation of the BWA and SWA landfills. Since Alternative 2 only includes residential contingencies, installation and operation will be simplified in comparison to the above alternatives. Details regarding construction and operating technologies and process options are discussed below.

Gas extraction wells would be installed in the Solid Waste Area in Alternatives 3A through 4B. Installation of the wells would necessitate drilling into disposal areas. Obstructions may be encountered in the disposal areas, which may complicate the drilling operation. Installation of the perimeter LFG collection system would be complicated by the power lines and proximity of residences along Rose Hill Road. The perimeter system should be constructed outside the limit of waste. However, this may only be possible if some perimeter wells are installed within Rose Hill Road.

Cap construction in Alternatives 3A through 4B would require stripping existing vegetation, installation and seaming of a geomembrane, backfill and compaction of the soil components of the cap, and revegetation. Installation of the geomembrane would be complicated by the numerous gas extraction wells. The top of each extraction well would penetrate the cap and the measures taken to prevent leakage around these penetrations would slow and increase the cost of the cap installation. Level B PPE may be necessary especially during invasive construction activities. This would slow the schedule and increase the cost of construction significantly.

Alternatives 4A and 4B would also involve the construction of a leachate collection and management system. Portions of the leachate collection and management system may be in disposal areas, which would cause the similar problems as mentioned above with respect to the landfill gas collection system. The leachate management system would involve building construction, connection of the different skid mounted processes, utility connection, and piping from the extraction systems.

Administrative Feasibility

Institutional controls (access and deed restrictions) are included in Alternatives 2 through 4B; therefore, administrative feasibility is the same with respect to this component. Effort required for administrative implementability will increase incrementally from Alternatives 3A through 4B because those alternatives include the construction of landfill gas collection and treatment and leachate collection and management systems. Further administrative feasibility details are described below.

Implementation of restrictive covenants in the form of property deed restrictions in Alternatives 2 through 4B would require significant long-term coordination between federal, state, local authorities, and private property owners.

Environmental monitoring programs proposed under all five alternatives would require coordination with the State of Rhode Island and the property owners of record. Long-term coordination would be required for analytical services and review and maintenance of data.

Under CERCLA, actual permits are not required for remediation activities. Compliance with the substantive requirements of the permit is, however, required. Thus, while an air permit would not be required for operation of the enclosed flare or photocatalytic oxidation unit in Alternatives 3A through 4B, designs must meet state standards. The condensate storage tank and pump stations would need to be designed and installed in compliance with state and federal rules, including appropriate UST rules.

Availability of Services and Materials

Contractors familiar with landfill gas applications would be required to install residential contingency control systems in Alternative 2. Large volumes of capping materials (topsoil, earth, sand, etc., some of which may be available locally or within the Site boundary and which could be used where appropriate) would be necessary under Alternatives 3A through 4B. Construction contractors familiar with methane safety as well as fugitive vapors/COCs would be required for Alternatives 3A through 4B. Also for those alternatives, fabrication of the LFG treatment system would take significant lead time and may be limited to specific, specialty contractors. Contractors would be necessary for construction of the extraction system, discharge wells, leachate management system, building, and piping in Alternatives 4A through 4B. OSHA-trained contractors will be required for landfill excavation, consolidation, and cap construction under Alternatives 3A through 4B. In all alternatives, consulting specialists, equipment and services are readily available to perform monitoring.

Alternatives 3A through 4B will generate a waste stream (landfill gas condensate) that may require disposal at a RCRA-compliant TSDF. Alternatives 4A and 4B may require disposal of any wastewater management system byproducts. There may also be a need for a RCRA-compliant TSDF if hazardous waste is encountered during the landfill excavation/consolidation process (Alternative 4B). Although there are no RCRA-compliant facilities in Rhode Island which would accept these RCRA wastes, availability of this service is not expected to present any difficulties.

7. Cost

A detailed summary of costs for each alternative is presented in Appendix G of the Feasibility Study (Administrative Record at Section 4.6). A revised summary of costs for alternatives 4A and 4B are also presented in the Administrative Record at Section 4.1. The total net present cost (capital plus operations and maintenance over the duration of the remedial action) for the six alternatives evaluated ranges from \$3.57 million to \$18.04 million. The cost summary presented in Table 5-2 of the Final Feasibility Study has been updated for the Record of Decision (see Table 75).

The cost differential between Alternatives 1 and 2 is relatively low (\$0.3 million) as the major cost component for each would be annual expenditures associated with environmental monitoring. Both alternatives have a relatively low capital cost component. The costs of Alternative 3A (\$13.4 million) and 3B (\$13.2 million) are significantly more than the previous two alternatives. The additional costs are required principally for installation of the cap(s), and an active internal and perimeter landfill gas collection and treatment systems. The difference in costs between Alternatives 3A and 3B is due to capital costs of the two LFG treatment systems. Landfill gas collection and treatment is conducted for a 15-year duration based on estimates of LFG production. The difference in costs between Alternatives 3A (\$13.42 million), 3B (\$13.19 million) and that of 4A (\$16.06 million) is leachate control and management predominantly for the Bulky Waste Area over the long term at an additional cost of \$2.64 or \$2.87 million, respectively. Alternative 4B (which includes excavation and consolidation of the Bulky Waste Area) adds an additional \$2 million and allows for leachate collection and management during the excavation and consolidation of the Bulky Waste Area.

The costs presented above are estimates which may be used to compare the relative expense of each alternative. A 20% contingency is utilized to account for any inaccuracy in the costs. Based on the accuracies of the estimates, the cost differences between alternatives may not be significant. To provide a better analysis of the costs, cost sensitivities are provided as described below.

Key cost variables were tested to determine the cost sensitivity of each of the alternatives. The results of this sensitivity analysis were originally presented in Table 5-2 of the Final Feasibility Study and updated accordingly in Table 75 of this ROD. The variables tested include: discount rate (for net present worth estimation), total capital costs, total annual (e.g. O&M) costs, contingency, and O&M duration related to the landfill gas components of each alternative.

Variation of the discount rate was evaluated at 5 % and 9%. These values are estimated to be reasonable lower and upper bounds, respectively, for long-term financial performance and reflect values above the rate of inflation.

Total capital and annual costs were varied from the base case by a +50% increase and -30% decrease. This range was selected based upon the minimum accuracy of the costs required pursuant to EPA's RI/FS guidance.

Variation of the contingency costs were evaluated at 15 % and 25%. These values are estimated to be reasonable lower and upper bounds, respectively, for the degree of cost unknowns associated with these remedial alternatives.

O&M duration of the landfill gas components of each of the alternatives was varied based on the range of times possible for natural attenuation of landfill gas from the Solid Waste Area. As described in Section 4.1.2.5 of the Feasibility Study, the Solid Waste Area is expected to generate landfill gas for 5 to 15 years. Since 15 years was evaluated as the base case, lower durations were used in the cost sensitivity of 5 years (low value of range) and 10 years (midpoint of range).

In Table 5-2 of the Final Feasibility Study, "Overall" costs reflect the highest and lowest total cost of each alternative for any of the variables evaluated. Based on this, the potential sensitivity range of costs varies from a low value of $3.57 million (for Alternative 1) to a high value of $18.04 million (for Alternative 4B).

Treating the landfill gas via an enclosed flare was selected over the photocatalytic oxidation for its proven track record as a technology readily available and for an insignificant percentage increase in cost compared to photocatalytic oxidation. The significant improvement realized by selecting excavation and consolidation over capping in place (alternative 4A versus 4B) is the permanent removal of a primary source of contamination from the vicinity of the River resulting in a far greater reduction of leachate production rather then the construction and long-term operation and maintenance of a leachate collection and management system for the Bulky Waste Area if capped in place.

8. State Acceptance

The State's comments on the Proposed Plan are provided in Appendix D, the Responsiveness Summary. In general, the State has expressed its support for Alternative 4B with modifications. The State does not believe that Alternatives 1,2, 3A, 3B, and 4A provide adequate protection of human health and the environment. The State supports deferring the decision as to the need for groundwater treatment to sometime in the future, when the decision on ground water is based upon presumably improved conditions resulting from the source control measures taken under this response. The State believes that the remedy selection as outlined herein accurately defines, recognizes and complies with all environmental regulations promulgated by the Department of Environmental Management. The State of Rhode Island concurs with the selected remedy. The State's letter of concurrence, documenting the State's position on the selected remedy is provided in Appendix C of this ROD.

9. Community Acceptance

The comments received from the community on the RI/FS and the Proposed Plan during the public comment period and EPA's responses to these comments are summarized in the Responsiveness Summary in Appendix D.

During the public comment period, the Proposed Plan offered the alternatives evaluated here and two additional management of migration alternatives. The community expressed its support for all alternatives except alternatives 1 through 3B, which they felt to be inadequately protective. Many of the comments received from the community raised serious objections to EPA's preferred alternative presented in the Proposed Plan. There was considerable concern that merely capping the Bulky Waste Area in place and conducting further study to address leachate and groundwater would not eliminate a significant source of contaminants to the Site surface waters. As a result of these comments and in light of new information presented during the public comment period, EPA modified its remedy to actively address the Bulky Waste Area through excavation and consolidation.

XI. THE SELECTED REMEDY

The selected remedy is Alternative 4B, modified to take into account its role as the first operable unit of a phased approach to remediate the environmental contamination caused by the Site. By implementing Alternative 4B as a first operable unit, the remedy will control the sources of contamination at the Site by limiting the extent to which precipitation will percolate and infiltrate through waste materials and minimizing the further migration of the contaminated groundwater plume. Management of the migration of contaminants from the Site will be based on data obtained from monitoring conducted under the first operable unit and any additional studies that are deemed necessary to further assess Site impacts, characterize the extent of contamination, and assess the need to develop and evaluate alternatives for future actions.

In summary, this first operable unit remedy provides the following components:

1. Excavate and consolidate the Bulky Waste Area landfill materials onto the Solid Waste Area landfill;

2. Collect and effectively manage leachate and waters collected from runoff and de-watering operations during the excavation of the Bulky Waste Area ;

3. Construct a multi-layer hazardous waste cap using innovative and cost efficient cover materials, as may be appropriate and as further defined in design, over the extent of the Solid Waste Area landfill and consolidated Bulky Waste Area materials;

4. Inspect and monitor the integrity and performance of the landfill cap over time;

5. Assess, control, collect, and treat landfill gas emissions by an active internal and perimeter gas collection system and thermal treatment of such gasses through the use of an enclosed flare and continue monitoring landfill gas concentrations to assess the need to modify the landfill gas collection treatment system as necessary;

6. Implement access restrictions and Institutional Controls (land title restrictions including, but not limited to, easements and restrictive covenants) on land use and the use of, or hydraulic alteration of, groundwater where Preliminary Remediation Goals (PRGs) (based on MCLs, MCLGs) and/or other health based standards are exceeded.

7. Install a chain link fence and/or other physical barriers where necessary to prevent Site access, injury and/or exposure;

8. Long-term monitoring of surface water, groundwater air and leachate emergence;

9. Perform operation and maintenance activities throughout the life of the remedy; and

10. Conduct statutory five year review as required.

The Bulky Waste Area will be excavated to the extent necessary to ensure that all municipal solid waste from the designated area is properly excavated, collected and consolidated onto the Solid Waste Area landfill. Information gathered by the Town in April 1999, indicates that a portion of the Bulky Waste deposits are in contact with the ground water table. Therefore, appropriate de-watering and leachate collection operations, including the collection and management of excavation trench waters and runoff from the staged materials, will be necessary. Proper on-site management and disposal strategies for such waters will be developed in design and implemented during construction. Possible management options are: On-site discharge without treatment, onsite discharge with treatment by precipitation, media filtration, ultraviolet/chemical oxidation, or off-site disposal dependent upon contaminant characteristics and/or concentrations in these process waters. These collected waters will be discharged on-site either through groundwater recharge wells, in which case the substantive provisions of the Rhode Island Rules and Regulations for Groundwater Quality and Rhode Island Underground Injection Control Regulations will be met, or by discharge to surface water, in accordance with the state regulations for Water Pollution Control and Ambient Water Quality Criteria (Water Quality Regulations and Water Quality Standards). The extent to which the Bulky Waste Area is excavated will be based on past data, design assessments, repetitive visual inspection of the excavation base and side walls, bucket observations, and other methodologies developed in the design phase to assure, to the greatest practical extent, that all physical evidence of waste deposits are removed from the Bulky Waste Area, irrespective of the level of groundwater within the excavation. The goal of this source control component is to effectively remove and contain the contaminant mass so as to significantly reduce contaminant migration through leachate production to surface waters and sediments of Mitchell Brook and the Saugatucket River and to reduce migration of landfill gas.

Waste materials will be properly staged prior to consolidation onto the Solid Waste Area. The Solid Waste Area will be appropriately prepared (grubbed and dressed) such that consolidation of the waste materials is timely and without unnecessary delay. Monitoring of hazardous conditions, runoff, fugitive dust emissions, and nuisance odors will be conducted throughout the response and contingency planning. Engineering controls will be implemented if necessary to mitigate any adverse impacts.

The use of innovative cap construction materials will be evaluated in the design phase for cost effectiveness while maintaining long-term effectiveness and permanence. Additionally, the EPA-NE technical guidance concerning alternative cap design will also be consulted and considered during the design phase. The cap will be designed and constructed to meet state hazardous waste closure requirements. The use of onsite materials for cover material will be considered where appropriate. Landfill gas emissions will be extensively monitored and controlled as required through the use of an active internal and perimeter gas collection and treatment system and on-site thermal destruction of COCs using an enclosed flare. The flare's destruction removal efficiencies for COCs will meet State and Federal ambient air quality standards. Assessments of gas constituents, concentrations, flow rates, piping and flare sizing will be conducted during design to determine the most efficient system needed and enhance and detail the construction specifications of the gas collection and treatment system. Long-term monitoring of landfill gas concentrations and treatment system performance will be conducted to evaluate and determine modifications necessary for system efficiency or other changes in landfill gas treatment.

The remedy also includes a long-term monitoring program, institutional controls, and operation and maintenance.

The costs and cleanup time frames for the selected remedy are summarized as follows:

Estimated Time for Design and Construction:	*2-3 years*
Estimated Time of Operation:	*<15 years for LFG; >30 years GW/Leachate*
Estimated Capital Cost:	*$11,360,000*
*Estimated Operations and Maintenance Costs (**net present worth**):*	*$6,680,000*
*Estimated Total Cost (**net present worth**):*	*$18,040,000*

As provided in the NCP, EPA will conduct a review of the Site at least once every five years after the initiation of remedial action at the Site since hazardous substances, pollutants and contaminants will remain at the Site. This will ensure that the remedial action continues to protect human health and the environment.

An expected outcome of the selected remedy is that the Solid Waste Area will no longer present an unacceptable risk to area residents and those at the Site through the inhalation of landfill gas. Another expected outcome of the selected remedy is that ground water in the vicinity of the Site will not present an unacceptable risk to area residents through ingestion as a result of the use of institutional controls. The second operable unit will address management of migration. The selected remedy will also provide environmental and ecological benefits such as incremental improvement of a riverine and wetland ecosystem by minimizing contaminant migration into wetland habitat adjacent to the River, and by improving the resource of the upland area associated with the former Bulky Waste Area.

XII. STATUTORY DETERMINATIONS

The remedial action selected for implementation at the Rose Hill Regional Landfill Superfund Site is consistent with CERCLA and, the NCP. The selected remedy is protective of human health and the environment, attains ARARs and is cost effective. The selected remedy partially satisfies the statutory preference for treatment which permanently and significantly reduces the mobility, toxicity or volume of hazardous substances as a principal element. Additionally, the selected remedy utilizes alternate treatment technologies or resource recovery technologies to the maximum extent practicable.

A. The Selected Remedy is Protective of Human Health and the Environment

The remedy for the Rose Hill Regional Landfill will permanently reduce the risks posed to human health and the environment by controlling exposures to human and environmental receptors through treatment, engineering controls, and institutional controls. Specifically, the risk presented by this Site is the possible exposure to and ingestion of contaminated groundwater and exposure to and inhalation of contaminated air. The selected remedy uses a combination of consolidation, capping of wastes and collecting and treating landfill gases and institutional controls to prevent or minimize the continued release of hazardous substances from the Site.

B. The Selected Remedy Attains ARARs

This remedy will attain all applicable or relevant and appropriate federal and state requirements.

Environmental laws from which ARARs for the selected remedial action are derived can be found in Table 76, in Appendix B of this Record of Decision. The table provides a brief synopsis of the ARARs and an explanation of the actions necessary to meet the ARARs. These tables also indicate whether the ARARs are applicable or relevant and appropriate to the actions to be taken at the Site. In addition to ARARs, the tables describe standards that are To-Be-Considered (TBC) with respect to remedial actions. A full description of the ARARs are also located in Section 4 Administrative Record (Feasibility Study).

The principal ARARs are also discussed below.

Principal ARARs for Groundwater

The purpose of the remedy selected in this ROD is to control the sources of contamination; therefore, no groundwater cleanup levels are established in this ROD. Since no cleanup levels are established, no chemical specific ARARs for groundwater have been identified.

The action specific ARARs for source control include groundwater requirements set out in the Rhode Island Rules and Regulations for Groundwater Quality, and the more stringent of the Rhode Island Rules and Regulations for Hazardous Waste, or the federal hazardous waste rules at 40 CFR 264 Subtitle F, and 40 CFR 258 Subtitle E. Because groundwater cleanup levels are not established in this ROD, only those provisions related to implementing a groundwater monitoring program will be complied with. In addition, maximum contaminant levels and non-zero maximum contaminant level goals (MCLs/non-zero MCLGs) in the Safe Drinking Water Act have been identified as action specific ARARs solely for the purpose of measuring the performance of the source control remedy.

If the underground injection option is selected in connection with the dewatering of the Bulky Waste during consolidation, action-specific ARARs include the substantive requirements of the RI Rules and Regulations for Underground Injection Control.

Principal ARARS for Surface Water

Chemical and action specific ARARs address the protection of surface water bodies.

If the surface water discharge option is selected in connection with the dewatering of the Bulky

Waste during consolidation, action-specific ARARs include the substantive requirements of the NPDES provisions of the Clean Water Act, and those of the RIPDES program if more stringent than the federal requirements. Additionally, the Rhode Island Water Quality Standards and Water Quality Regulations define the water quality antidegradation policy of the State. The Rhode Island Water Quality Standards are based on Federal Ambient Water Quality Criteria which set standards for surface water quality for the protection of human health and aquatic life. Any state standards which are more stringent than federal standards must be complied with if the surface water discharge option is selected. The ecological Preliminary Remediation Goals presented in Table 78 list background levels for aluminum and manganese and the AWQC concentration. Although not cleanup levels, the source control remedy will reduce surface water concentrations as close as possible to these levels.

Principal ARARs for Wetlands

State and Federal regulations for the protection of wetlands are closely linked with those for the protection of surface water bodies; however, protection of wetlands is based on location specific criteria. Generally, actions are required to minimize or prevent the destruction, degradation, alteration or net loss of wetlands, as defined by the State of Rhode Island Department of Environmental Management Freshwater Wetlands Act and Federal Protection of Wetlands Executive Order regulations.

Principal ARARs for Air Quality

Air quality protection requirements are action-specific. Federal National Ambient Air Quality Standards (NAAQS) are not ARARs but are guidelines for specific criteria pollutants for air emission sources. NAAQS define levels of air quality which the EPA judges are necessary to protect public health. The State Air Pollution Control Regulations must contain, at a minimum, the federal air quality requirements. Landfill gas controls will meet the NESHAPs for vinyl chloride and benzene. Federal air regulations also require the collection, control and monitoring of Non-Methane Organic Compounds (NMOCs) such as benzene and ethane. RCRA requirements for air emissions from thermal units, process vents and equipment leaks are also included as ARARs. The human health Preliminary Remediation Goals are presented in Table 79. Although not cleanup levels, the remedy will reduce contaminant concentrations in ambient air as close as possible to these levels.

State Air Pollution Control Regulations mandate compliance with specific standards for such parameters as particulate emissions, installation of air pollution control and monitoring equipment and adherence to the Federal NAAQS. Included in the State Air Pollution Control Regulations are the State Air Toxics Regulations. This regulation prohibits emission of specified contaminants at rates which would result in ground level concentrations greater than acceptable ambient levels set in the regulation. Acceptable ambient levels are specified as maximum contaminant concentrations contributed by a stationary air toxic source at or beyond the facility property line.

Principal Hazardous Waste ARARs

Hazardous Waste Management regulations are action-specific ARARs. Federal regulations governing the management of hazardous waste are promulgated under the Resource Conservation and Recovery Act (RCRA). The State of Rhode Island was granted final authorization by EPA in 1986 to administer its hazardous waste program in lieu of the federal government's base RCRA program. The state program is set forth at Rule 5.00 et seq. of the "Rules and Regulations for Hazardous Waste Management" (Rhode Island Hazardous Waste Rules), as amended. Thus, these state regulations govern the management of hazardous waste activities and set operational standards for hazardous waste management facilities.

Principal To Be Considered Requirements

EPA's regional guidance for the capping of hazardous waste landfills will be considered during the design phase in order to develop a cap for the Site which meets the performance standards of both the Rhode Island Hazardous Waste Rules and RCRA Subtitle C. EPA's Technical Guidance Document on Final Covers on Hazardous Waste Landfills and Surface Impoundments, which provides guidance on constructing landfill caps to meet RCRA subtitle C requirements, will also be considered during design of the cap.

C. The Selected Remedial Action is Cost-Effective

In the Agency's judgment, the selected remedy is cost effective, i.e., the remedy affords overall effectiveness proportional to its costs. In selecting this remedy, once EPA identified alternatives that are protective of human health and the environment and that attain ARARs, EPA evaluated the overall effectiveness of each alternative by assessing the relevant three criteria: Long term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short term effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs. The revised costs of this remedial alternative are summarized in Table 80 of this ROD.

EPA believes that the combination of consolidation, capping and landfill gas treatment is sufficient to: 1) prevent migration of landfill gas; 2) prevent consumption of groundwater through the use of institutional controls; 3) reduce production of leachate to prevent the further degradation of surface waters and improve aquatic life.

While it is an effective source control remedy, it is not known whether source control alone will achieve a permanent or long-term solution to all risks posed at the Site. The assessments conducted under the first operable unit will assess the effectiveness of the remedy implemented pursuant to this ROD, at which time further remedial action may be determined to be necessary to achieve a permanent solution to the risks posed by the groundwater and surface water contamination at the Site. Additional costs that would be incurred to implement a remedy designed to manage the migration of contamination at the Site (for example, through installing a groundwater collection and treatment system) may not be necessary if the selected remedy proves sufficient as a long-term, permanent solution.

D. The Selected Remedy Utilizes Permanent Solutions and Alternative Treatment or Resource Recovery Technologies to the Maximum Extent Practicable

Once the Agency identified those alternatives that attain ARARs and that are protective of human health and the environment, EPA identified the alternative which best utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. This determination is based on balancing the following factors: 1) long-term effectiveness and permanence; 2) reduction of toxicity, mobility or volume through treatment; 3) short-term effectiveness; 4) implementability; and 5) cost. The balancing test emphasized long-term effectiveness and permanence and the reduction of toxicity, mobility and volume through treatment; and considered the preference for treatment as a principal element, the bias against off-site land disposal of untreated waste, and community and state acceptance. The selected remedy provides the best balance of trade-offs among the alternatives.

E. The Selected Remedy Satisfies the Preference for Treatment Which Permanently and Significantly Reduces the Toxicity, Mobility or Volume of the Hazardous Substances as a Principal Element

CERCLA and the NCP set forth the process by which remedial actions are evaluated and selected. Because many CERCLA municipal landfill sites share similar characteristics, they lend themselves to remediation by similar technologies. EPA has established a number of expectations as to the types of technologies that should be considered and alternatives that should be developed; they are listed in the National Contingency Plan (40 CFR 300.430(a)(1)) and EPA Guidance Document "Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites" EPA/540/P-91/001. See Section VIII. B. for a detailed list of expectations for remediating municipal landfills.

Each of the above criteria has been met in selecting alternative 4B as a source control remedy. Principal threats posed by the Site include the exposure to and inhalation of landfill gas and the exposure to and ingestion of contaminated groundwater. Through the use of active landfill gas control and treatment technology, the air exposure pathway will be addressed by collecting and permanently treating the gases with an enclosed flare. Institutional controls coupled with long-term monitoring will prevent exposure to and ingestion of contaminated groundwater. Operable unit two will further address site risks from groundwater and surface water, if necessary. Engineering controls in the first operable unit, including the excavation, consolidation of the BWA onto the SWA and construction of a protective cap, will contain and may accelerate natural attenuation of the contamination. Data produced from the monitoring programs in the first operable unit will determine the need for any future response actions at the Site.

XII. DOCUMENTATION OF SIGNIFICANT CHANGES

On February 2 , 1999, EPA presented a Proposed Plan (preferred alternative) for remediation of the Site. EPA's Preferred Alternative, as presented in the Proposed Plan, was Alternative 3A.

During an extended public comment period (from February 2, 1999 to May 3, 1999) the public, State and local representatives expressed strong concerns about certain aspects of the preferred alternative, in particular the in-place capping of the Bulky Waste Area landfill. The opposition to capping the BWA was based on its close proximity to the Saugatucket River and the ecological risk to the benthic aquatic communities within the River. State and local representatives and members of the public preferred an alternative that would remove the Bulky Waste Area and consolidate and cap this waste material with that of the Solid Waste Area thereby providing an additional measure of protection for the area along the River. During the Public Comment Period, the Town of South Kingstown presented EPA with new information demonstrating that the Bulky Waste Area may be predominantly comprised of municipal solid waste, contrary to previous information supplied by the Town during the RI. This information, together with the public's desire to provide further protective measures for the River, led EPA to reevaluate its preference.

The NCP allows EPA to re-evaluate its remedy preference in response to new information and in consideration of comments received during the public comment period. After consideration of all the public comments received on the Proposed Plan, and in light of the new information as described above, EPA is of the opinion that these changes do not require the issuance of a new Proposed Plan. While EPA has selected a modified remedy from the preferred remedy described in the Proposed Plan, the remedy selected and described in the ROD is essentially the same but for two exceptions: 1) the Bulky Waste Area will be excavated and consolidated onto the Solid Waste Area instead of capped in place; and 2) a leachate collection and management system is included. This remedy was presented as Alternative 4B in the FS and Proposed Plan.

In the course of its review of public comments on the Proposed Plan, EPA noted an error in its calculation of costs concerning alternative 4B. The error was in the calculated sum concerning landfill consolidation costs relating to cost recovery of reclaimed metals. Therefore, the revised cost for this alternative based on the final FS Report assumptions are as follows: A capital cost of $8.3 million and an O&M cost of $7.1 million for a total of $15.4 million. The Proposed Plan estimated $16.9 million for the cost of alternative 4B, resulting in a difference of $1.5 million. This cost differential is inconsequential, however, in light of EPA's guidance for Feasibility Studies which permits estimates to have an accuracy of +50 percent to -30 percent. When presented with the new information from the Town of South Kingstown, EPA revised its cost estimate to reflect an increase in materials use, volume of wastes to be excavated/consolidated (minus the cost to reclaim metals), and length of time to complete the tasks. The resulting total costs are those set forth in the ROD for Alternative 4B and reflect an increase of approximately $1 million over the costs presented in the Proposed Plan, or approximately $2.6 million over the estimated costs in the revised estimate in the Administrative Record at section 4.1.

Finally, this Record of Decision clarifies EPA's position concerning its approach in assessing the need for conducting any additional remedial responses concerning groundwater and surface water as a component of the long-term monitoring program. EPA has identified this remedy as a first operable unit of a two operable unit approach to remediate the environmental contamination caused by the Site. The first operable unit will control the sources of contamination at the Site by limiting infiltration and percolation of precipitation through waste materials which are causing a continued release of hazardous substances to the air, ground water and surface water. Further migration of hazardous substances, pollutants and contaminants to groundwater and surface water will therefore be minimized. Once the source control remedy is implemented, further studies will evaluate the need to manage the migration of contaminants from the Site. Management of the migration of contaminants from the Site will be based on data obtained from the first operable unit monitoring and any additional studies that are deemed necessary in order to further assess Site impacts, characterize the extent of contamination, and assess the need to develop and evaluate alternatives for future actions should it be found necessary to do so.

XIII. STATE ROLE

The Rhode Island Department of Environmental Management has reviewed the various alternatives and has indicated its support for the selected remedy. The State has also reviewed the Remedial Investigation, Risk Assessment and Feasibility Study to determine if the selected remedy is in compliance with applicable or relevant and appropriate State Environmental laws and regulations. The State of Rhode Island concurs with the selected remedy for the Rose Hill Regional Landfill Superfund Site. A copy of the declaration of concurrence is attached as Appendix C.